Board IT Competence and Firm Performance

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Abstract

In this study, we theorize a new construct 'board IT competence', and show that it is systematically related to firm performance. Using a sample of 32,856 firm-years observations over the period of the year 2000 to 2018, our study shows that board IT competence is positively associated with firm performance. Moreover, the findings suggest that firm performance is not only higher, but also more consistent across time. While many firms find it difficult to identify the right sources in developing IT competence at the board level, our study suggests that a board composition that promotes the representation of directors with relevant IT competencies can offer valuable insights to mobilize and reconfigure IT asset to create firm value.

Keywords: Board IT Competence, Board of Directors, Firm Performance

Introduction

Prior research on information systems leadership has emphasized the importance of the board of directors in developing IT governance (Andriole 2009; Huff et al. 2006), but has largely limited itself to examining how specific board characteristics influence the level of IT investment or the creation of a Chief Information Officer (CIO) position in the organization. For example, younger boards and boards with more IT-experienced external board members are associated with larger IT investments and the presence and role of a CIO (Kambil and Lucas 2002; Karake 1995). Nonetheless, there is a dearth of literature examining how IT knowledgeable board of directors as a strategic decision-making and monitoring mechanism directly affects firm performance. In this context, we develop the premise that the IT experience in the board of directors is positively associated with firm performance. Using agency theory, resource dependence theory, and strategic choice theory, we theorize the construct of board IT competence, and examine its impact on firm performance. Drawing on to pervious information systems literature, we suggest that shareholders value the strategic importance of having an IT competent board. We conceptualize and measure two alternative measures of IT competencies at the board level. First, we measure prior executive or board experience in the IT sector. That is, we measure whether the director at one point in his career has had a high profile function in an IT firm, which would allow that director to develop a profound knowledge of IT.

Second, we construct a measure of executive IT competence, where we specifically observe whether the director has functioned as a Chief Executive Officer (CEO), CIO, or Chief Technology Officer (CTO) in the IT sector. Senior executive positions have a considerable impact on firms IT-related decisions both at operational as well as strategic level (Banker et al. 2011; Lim et al. 2013b; Schein 1992). IT knowledge developed in executive positions can therefore be more valuable towards enhancing a firm's IT capability and performance. We therefore expect the effects of board IT competence to be greater for boards with executive IT competence.

Using a sample of 32,856 firm-years observations over the period of the year 2000 to 2018, the results show that board IT competence is positively associated with firm performance for both measures. Moreover, performance is not only higher, but also more consistent across time. However, the effects of IT competence and executive-based IT competence are not statistically different from one another. In aggregate, our results indicate the importance of IT competent boards.

Background and Hypothesis

Corporate governance literature suggests that the board of directors is not only involved in monitoring the corporate activities of the executive management on behalf of shareholders, but also in the provision of resources (Hillman and Dalziel 2003). The term resource provision encompasses a large set of activities performed by the board members. A few of these activities include participating in strategy formulation (Pugliese et al. 2009), building external relations, and encouraging R&D activities (Baysinger et al. 1991; Hillman and Dalziel 2003; Judge Jr and Zeithaml 1992). For the past two and half decades, the studies on the board of directors have shown that the board acts as central mechanism between changes in the external environment of the firm and the internal situation of the firm (Pearce and Zahra 1992). In other words, the extant research suggests that the board of directors have been instrumental in providing advice and direction on the topics of strategic relevance to the focal firm. In this view, information technology (IT) has emerged as one of the key strategic assets to gain a competitive advantage (Mata et al. 1995; Piccoli and Ives 2005).

Acknowledging the significant impact of IT on firm value, and the risks and opportunities that IT assets entail, the information systems literature has endorsed the role of board of directors in governing IT (Mähring 2006; Nolan and McFarlan 2005; Trites 2004; Valentine and Stewart 2013). IT governance is essentially a mix of structures, processes, and relational mechanisms (De Haes and Van Grembergen 2015; Tiwana et al. 2013; Wu et al. 2015; Xue et al. 2019). Governing these IT structures and processes then is "the responsibility of the board of directors and executive management in achieving an organization's strategies and objectives" (ITGI 2003, p. 10). This definition emphasizes the structural component of IT governance, and explicitly focuses on the composition and role of the board of directors within the ambit of IT topics.

Although the current literature has strongly advocated the role and influence of the board of directors in IT governance (Turel et al. 2019), the majority of scholarly publications on IT governance have limited their scope to the impact of executive managers such as the CIO and CEO (e.g. Banker et al. 2011; Chatterjee et al. 2001). Nevertheless, over the past few years, next to financial and legal matters, IT-related topics are dominating the board agenda. This in turn has also reflected in some recent academic publications that have exclusively focused on the role and influence of the board of directors in governing IT (Turel and Bart 2014; Turel et al. 2019).

While these studies have contributed to the literature on the board level IT governance, there is yet a limited understanding whether the association between IT competence at the board level might directly influence firm performance. In this study, we argue that IT competent boards can be instrumental in advising on how to leverage new emerging technologies, how to prioritize IT investments, and how to formulate digital business strategy (Bharadwaj et al. 2013). As a result, IT competence at the board can directly influence firm performance. In a recent study, Weill et al. (2019) argue that board members having experience in digital business is a new financial performance differentiator. That is, the study finds that IT savvy board members outperform not savvy board on the criterion of return on assets, revenue growth, and market capitalization growth. We extend and refine this research stream with more empirical rigor and providing more theoretical underpinning to the construct of board IT competence.

Board IT Competence

Consistent with Benaroch and Chernobai (2017, p. 735), we define board IT competence as "the board's ability to perform its IT governance monitoring and service functions." The term monitoring essentially captures the board's responsibility in monitoring actions and decisions of executive management on behalf of shareholders (Fama 1980; Shleifer and Vishny 1997). This responsibility is consistent with agency theory (Jensen and Meckling 1976), which describes that the board of directors serve as a monitoring mechanism to protect the interest of shareholders from the opportunistic behavior of managers. In this view, IT governance monitoring mainly warrants the board of directors to provide oversight on IT investment decisions (Ho et al. 2017), and the monitoring and mitigation of IT risks including competitive threats (Higgs et al. 2016; Ho et al. 2011; Parent and Reich 2009; Xue et al. 2011; Yang et al. 2018). On the other hand, according to Benaroch and Chernobai (2017, p. 733), the service function of IT governance involves "a range of activities, including reinforcing the public image of the firm's IT capability, providing IT expertise and IT counsel to management, enabling preferential access to external IT providers and other third parties, and aiding in the formulation of IT strategy." The authors draw on resources dependence theory (Hillman et al. 2009; Pfeffer and Salancik 1978) to suggest that the board functions as a resource provision mechanism. In other words, the board provides the focal firm access to 'external linkages and access to resources in order to limit its dependence on external entities' (Benaroch and Chernobai 2017, p. 733). Following this reasoning, IT competence clearly is an important resource to a firm. Jewer and McKay (2012 further find that the IT competency of the board of directors positively affects their involvement in IT governance. The authors interpret their findings as support for strategic choice theory (Child 1972; Judge Jr and Zeithaml 1992), which suggests that the board of directors acts as a change agent between the focal firm and its external environment. That is, the board members exhibit influence in designing strategic decision-making process to address external pressures (Judge Jr and Zeithaml 1992). IT competence then is a key condition for the board to be effective in fulfilling its role as a change agent.

Drawing on these theories, we claim that directors' prior experience in an executive or non-executive function in the IT sector constitutes a rigorous source of IT competence to perform the aforementioned IT monitoring and IT service function roles. That is, experience gathered by the board of directors within the IT sector fosters a continuous acquisition of IT knowledge and skills. This in turn can build strong IT competence in performing the IT governance monitoring and IT service functions. Moreover, experience gathered by the board of directors within the IT sector exhibits IT skills and competence to design superior IT capabilities, which can further help the focal firm to address competitive challenges exerted by the external pressures (Weill et al. 2019). In sum, agency theory, resources dependence theory, and strategic choice theory together provide a set of assumptions that permit to conceptualize board IT competence as a theoretical construct. We assert that the board IT competence embeds both the IT monitoring and IT service provision aspects of the board's role, which is vital and directly affects the firm performance.

The Impact of Board IT Competence on Firm Performance

Board IT Competence as a Strategic Resource

Considering the board of directors as an organizational resource (Hillman and Dalziel 2003), we can argue that board IT competence can serve as an important source to achieve firm performance. Specifically, board level IT competence should help a firm to achieve a high degree of synergy in mobilizing and deploying IT-based resources in combination with other organizational resources and capabilities. Boards with higher proportion of IT competence certainly can make better IT decisions, improve digital business strategy formulation, and enhance the governance of IT risks (Nolan and McFarlan 2005; Parent and Reich 2009). This is in turn can help the focal firm to create a distinct IT capability to achieve a competitive advantage. Using the resource based view of the firm, Mata et al. (1995, p. 500) concludes that "only IT managerial skills are likely to be a source of sustained competitive advantage." In other words, the most profound determinants of achieving competitive advantage are the upper echelons of the organization. We therefore claim that, if directors have developed valuable IT management skills through their prior affiliation to IT sector firms, this increases the board's IT competence and its ability to provide guidance on key IT decisions.

In this view, the extant corporate governance literature shows that board expertise directly influences firm performance. For instance, Klein (1998) finds that the percentage of inside directors is positively related to accounting and market-based performance measures. DeFond et al. (2005 observe a positive market reaction to the appointment of accounting financial experts assigned to audit committees. Huang et al. (2014 further show that for firms engaging in acquisitions, prior M&A experience in the board of directors helps improve long-term performance. Board expertise is consequently an important driver of firm performance.

Extending this notion to an IT setting, we hypothesize that board IT competence can directly influence firm performance in a similar way. Assuming that board IT competence is heterogeneously distributed across firms (Turel and Bart 2014), we posit that a higher level of board IT competence can positively impact firm performance. Turel and Bart (2014) conclude that, irrespective of the strategic role of IT, the involvement of the board of directors in IT directly impacts organizational performance. A study by Jewer and McKay (2012 corroborates this finding, showing that a higher level of board involvement positively impacts the contribution of IT to firm performance. Higgs et al. (2016 further show that a board-level technology committee serves as a signal to indicate the firm's ability to detect and respond to security breaches. The authors find that a board level technology expertise (in the form of a technology committee) mitigates the negative abnormal stock returns arising from external breaches. Hence, while shareholders may perceive IT competence at the board level as a potential mechanism to improve firm value, the IT monitoring function of the board might directly influence the operational effectiveness and efficiency of the focal firm as well. In other words, through efficient oversight of IT activities can IT competent boards review and monitor the progress of implementation of new or on-going technology projects. As a result, these firms may experience improvements in accounting performance next to market-based performance.

Executive Board IT Competence

Our study also aims to acknowledge that senior executive positions have a considerable impact on firms IT-related decisions both at the operational and strategic level (Banker et al. 2011; Lim et al. 2013b; Schein 1992). Specifically, we posit that IT competences are better-developed or more valuable when matched with executive experience. A director, who has worked for an IT firm in a senior management position such as CEO, CIO, or CTO, not only gathers invaluable IT skills, but also builds expertise in managing and integrating these IT skills in the organization. For example, a senior executive position as CEO, CIO, or CTO demands greater involvement in designing IT governance practices at the firm level (Weill and Ross 2004). Moreover, IT governance decisions that involve topics as IT investment prioritization, IT portfolio management, IT planning, and IT risk management warrant a strong involvement of the CEO and CIO (Weill and Ross 2005). Hence, it is likely that these senior executive managers gain considerable insights on the strategic integration of IT resources during their tenure. Therefore, prior experience as a senior executive in an IT-intense role can engage an individual in gaining IT competence at a strategic level, and directors having prior experience as CEO, CIO, and CTO in an IT firm can strongly enhance the board's IT competence. We therefore argue that boards of directors with a higher level of executive-based IT competence can be instrumental in improving firm performance.

Prior literature has extensively focused on the role of senior executives in IT, and their subsequent impact on firm performance. The central figures here again is the CIO. Lim et al. (2013a) examine the value implication of the CIO position, and find that firms with a formal CIO position shows higher levels of IT investments. Moreover, returns to these IT investments are greater for firms whose CIOs possess additional titles and/or expanded responsibilities. Along the same lines, Chatterjee et al. (2001 find that a strong positive impact of the announcement of a CIO position on abnormal stock market returns, confirming the strategic importance of the CIO position for a firm. A recent study by Benaroch and Chernobai (2017 observes an increased turnover rate of CIOs serving on the board after IT failure, suggesting that the role of CIO is directly linked to both value creation and destruction. The role of the CIO in creating firm value can also be linked to other senior executive positions. For instance, Banker et al. (2011) show in a longitudinal study that firms can achieve superior performance through aligning the reporting structure of the CIO with CEO or CFO, but that this is conditional on the competitive strategy of the focal firm.

As argued above, CEO, CIO, and CTO are involved in translating IT resources to performance, as IT investments and planning warrant involvement of these top executives (Weill and Ross 2005). Hence, important synergies likely exist between IT competence and executive experience. If at one point in his

career a board member functioned in the role of a senior executive in an IT firm, he or she will have actively integrated IT and operational resources with the goal of improving performance. The resulting IT competence may benefit the firm even more than the IT competence of board members who lack experience in a senior executive IT position.

Overall, we conceive and operationalize board IT competence in two alternative way. First, it is the competence developed by individual board member by working in the technology sector, and secondly if this experience is acquired in the executive position as a CEO, CIO or CTO. The purpose of this alternative approach is twofold. First, we aim to show that irrespective of the senior executive position held in the past, the experience acquired by the board members in the IT sector is instrumental for firm performance. Second, if the board member had gained the experience in the capacity of a CEO, CIO, or CTO in the IT sector, this will exert a greater impact on firm performance. In sum, drawing to above discussion, we propose following hypothesis for this study:

H1: Board IT competence is positively associated with firm performance

Research Methodology

Baseline Specification

To investigate the proposed hypothesis, we develop an empirical model in which we link the IT competence of the board (ITCOMP) to firm performance using a panel data set. The general outline of the model is based on Bharadwaj, Bharadwaj, and Konsynski (1999), Mithas, Tafti, Bardhan, and Goh (2012), and Van Peteghem, Bruynseels, and Gaeremynck (2018):

$$PERF_{it} = \alpha_0 + \alpha_1 ITCOMP_{it} + \alpha_2 CONTROLS_{it} + \alpha_3 YEAR\ FE + \alpha_4 FIRM\ FE + \varepsilon 1$$

The chosen output measure PERF reflects the performance of the firm, and is defined as accounting performance, market performance, and operational efficiency (Chae et al. 2014; Van Peteghem et al. 2017). Based on our hypotheses, we expect board IT competence to be associated with superior performance and a higher operational efficiency. We identify and include a set of control variables based on prior literature to help mitigate omitted variable bias and increase the explanatory power of our models. More detail on the control variables included in the model design is provided below and in Table 1. All continuous variables have been winsorized at the 1% level to mitigate the impact of outliers.

We include in our models both year and firm fixed effects. The inclusion of firm fixed effects helps capture time-invariant heterogeneity across firms and mitigates omitted variable bias. Firm fixed effects partial out the effects of time-invariant variables with time-invariant effects, increasing the explanatory power of our models and enhancing the robustness of our results. This is all the more important given the relatively stable nature of a firm's governance environment. The year fixed effects control for time trends across the general population of firms, e.g., during the financial crisis. We further cluster standard errors at the firm level to take into account heteroscedasticity. For panel data sets with firm fixed effects and a sufficient number of years, clustering at the firm level produces unbiased standard errors (Petersen 2009).

Measures of Firm Performance

We use two direct measures of firm performance, being return on assets (ROA) and stock returns (RET) (Cheng 2008). Whereas ROA targets core operating or accounting performance, RET captures market performance (Bharadwaj et al. 1999; Van Peteghem et al. 2017) (. We define ROA as EBIT (earnings before interest and taxation) divided by total assets. RET is measured as the percentage change in stock prices compared to the prior year. A third measure examines operational efficiency or cost leadership, which is a more specific way in which board IT competence may enhance firm performance, as the successful deployment of IT systems improves the efficiency of operational and supply chain processes within and across firms (Ilebrand et al. 2010). The implementation of high quality IT systems is further associated with lower operational costs via a reduction in inventory and cycle times (Banker et al. 2006; Ilebrand et al. 2010). We define OPEX as operating expenses before depreciation per employee, where operating expenses equal sales minus cost of goods sold and operating income (Mithas et al. 2012).

Table 1. Variable Definitions			
Variable Role	**Variable Name**	**Variable Definition**	**Data Source**
Dependent variables	*ROA*	(Earnings before interest and tax)/Total assets.	Compustat
	OPEX	(Sales - cost of goods sold - operating income)/Number of employees	Compustat
	RET	(End-of-year stock price - Beginning-of-year stock price)/Beginning-of-year stock price.	Compustat
Test variables	*ITCOMP*	The proportion of the board having IT competence based on their prior employment history.	BoardEx
	EXECITCOMP	The proportion of the board having developed IT competence in executive positions.	BoardEx
Control variables	*LNBSIZE*	The natural logarithm of the number of directors on the board.	BoardEx
	BINDEP	The proportion of independent directors on the board.	BoardEx
	LNMEANAGE	The natural logarithm of mean director age.	BoardEx
	LNTA	The natural logarithm of total assets.	Compustat
	LNMARKETCAP	The natural logarithm of the firm's market value.	Compustat
	LEVERAGE	Long-term debt divided by total assets.	Compustat
	INTANTA	Intangible assets scaled by total assets.	Compustat
	RDADV	(R&D expenses + Advertising expenses)/Sales.	Compustat
	MTB	Market value of equity over book value of equity.	Compustat
	LOSS	Dummy variable equal to one if net income was negative in the prior year, and zero otherwise.	Compustat
	ALTMANZ	Altman Z-score calculated following Altman (1968).	Compustat
	SALESGROWTH	Percentage change in sales over the prior three years.	Compustat
	STDOCF5Y	The standard deviation of operational cash flows over the prior five years.	Compustat
	STDRET5Y	The standard deviation of the firm's stock returns over the prior five years.	Compustat

Board IT Competence

We introduce a novel measure for capturing IT competence. Specifically, we operationalize board IT competence as the percentage of board directors having prior experience in an executive or board function in the IT sector, or as a CIO or CTO. In a first step, we extract all prior employment data from BoardEx for each director in our sample. BoardEx collects data on all high profile functions of directors. We then search his or her prior employments for any executive position in the IT sector, based on the industry classification of the firm in which the director holds the position. If an industry classification is unavailable, we perform a textual search on the company name for the following terms: "Computer", "Software", "Hardware", "Data", "Digital", and "Online". If a director works in an executive or board position in any of the IT firms identified using the prior steps, we posit that the director has developed IT competence in that position. In a second step, we survey the role of the director across employments, and classify all positions as a CIO or CTO as positions in which directors develop IT competence. The combination of these two steps provides us with a measure of IT competence at the director-year level, which takes on the value of one if the director has built up IT competence in any of the years prior to that year, and zero otherwise.

Using the same methodology, we construct a more specific definition of director IT competence to take into account the source of the IT competence. Prior research has shown the important impact of executives in sustaining a firm's information technology capability (Lim et al. 2013a). Hence, IT competence as an executive will likely be more valuable compared to non-executive IT competences. We therefore construct a similar IT competence variable, but equal to one only if the source of the director's IT competence is an executive position as CIO or CTO, or CEO in an IT firm. This measure thus requires that the board member was a key executive in an IT company in the past, rather than only a board member.

Figure 1 plots the percentage of IT competent directors across years. The bold line shows the percentage of directors having general IT competence, whereas the thin line shows the percentage of directors having developed IT competence in executive positions. The data show a clear increase in the proportion of directors having developed IT competences, which is in line with the recent IT revolution of the past two decades. IT companies have been booming, and so has the necessity of having strategic knowledge of IT systems in executive positions and the board. The proportion of directors with general IT competences increased from 15% to about 25%, and those directors having developed this competence in executive positions increased from 2.5% to over 5%. This pattern suggests that our measure matches the current IT revolution.

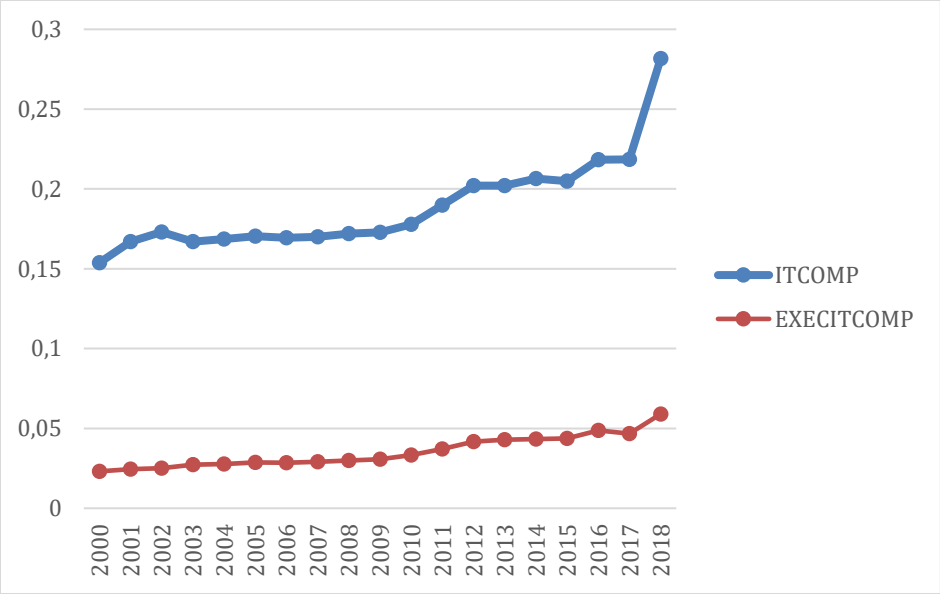

Figure 1. The development of IT competent boards across time.

We transform both competence variables to the board level by scaling the number of IT competent directors by the total size of the board. Our first variable is ITCOMP, which is the percentage of IT competent directors in the board using the broadest definition. Similarly, we construct a variable called EXECITCOMP using the narrow definition, targeting IT competence developed in executive positions.

Control Variables

We introduce a number of control variables to take into account omitted variable bias. We first control for various characteristics of the board of directors. First, we include the logarithm of board size (LNBSIZE), as prior research has shown the strong association between board size and firm performance (Coles et al. 2008). Larger boards are less prone to CEO influence, but may experience coordination difficulties, both of which may affect board monitoring and firm performance. Next, we include board independence, as independence is considered a necessary condition for strong board monitoring, and the market positively appreciates independent directors (Nguyen and Nielsen 2010). We define BINDEP as the number of independent directors in the board scaled by total board size. Third, we control for director age by including the logarithm of mean director age in the board (LNMEANAGE). Older directors are less likely to possess IT competence, as the IT revolution is a feature of the most recent decades. Older directors are more likely to have developed their core competence prior to the emergence of information technologies, and are less able to adapt to new technology following changed cognitive demands (Czaja and Lee 2007).

A second set of control variables relates to the firm's underlying fundamentals. First, we control for firm size via the logarithm of total assets (LNTA). Prior research has extensively documented the impact of size on firm performance, as well as its interrelation with technology. For the stock returns model, we use the natural logarithm of the market capitalization as the relevant control variable for firm size (LNMARKETCAP). We further control for leverage, as the monitoring effects of debtholders have been

shown to benefit prior research. LEVERAGE is defined as long-term debt scaled by total assets. We further control for the firm's intangible assets by including the amount of intangible assets scaled by total assets (INTANTA). IT investments have been shown to positively affect innovation output and intangible assets, which may translate into superior performance. Next, we control for R&D investments as well as advertising expenditures, as ample prior research has shown the positive association between these expenditures and firm performance (Bharadwaj et al., 1999). We set missing values for R&D and advertising expenditures equal to zero, which is a common procedure in prior research. R&D expenditures and advertising expenditures are aggregated and scaled by total sales (RDADV). Fifth, we control for firm growth opportunities by including the firm's market-to-book ratio (MTB). IT investments and firm growth have been strongly intertwined. Sixth, we include a dummy variable equal to one if the firm had a negative net income in the prior year, and zero otherwise (LOSS). This variable helps control for past performance, which is a strong predictor of future operating and market performance. Seventh, we control for a firm's financial stability via the Altman-Z score, as financially stable firms have more robust performance. Eight, we include the growth in sales over the prior three years (SALESGROWTH), to further control for the inherent growth of the firm, and the accompanying performance effects. Lastly, we control for cash flow volatility by including the standard deviation of the firm's operational cash flows scaled by total assets over the past five years (STDOCF5Y). For the stock return model, this variable is operationalized as the volatility of stock returns over the prior five years (STDRET5Y). Volatile operations have been shown to affect market perceptions of firm performance, as well as CEO management of operating performance.

Data and Setting

In testing our predictions, we rely on archival data. We obtain financial information necessary for our performance and control variables from Compustat North America. Governance data on individual directors is extracted from BoardEx, which collects amongst others prior employment history and personal characteristics of directors. All of our test and dependent variables are measured over a 2000-2018 period, which results in a final sample of 32,942 observations for the ROA model, 32,310 observations for the RET model, and 32,594 observations for the OPEX model, after the elimination all observations with missing values. Details on the sample selection procedure are shown in Table 2.

Empirical Results

Descriptive Statistics

Descriptive statistics on the variables used in our models are shown in Table 3. The descriptive statistics have been calculated on the largest sample, being the sample for the ROA model, except for the model-specific variables RET, OPEX, LNMARKETCAP and STDRET5Y. The average (median) ROA is 0.042 (0.072), whereas the average (median) stock returns in our sample equals 0.137 (0.046). Mean (median) operating expenses per employee equals 87.059 (54.209). These descriptive statistics are in line with prior research (Bhagat and Bolton 2008; Coles et al. 2008).

Mean (median) value of ITCOMP is 0.230 (0.125), which indicates the prevalence of directors with IT competence in the economy, and within the boards of directors. Tying this to the (untabulated) average board size being comprised of nine directors, about two directors in every board will have IT competence. Moving further to the more fine-grained measurements examining the origin of the developed IT competences (EXECITCOMP), the descriptive statistics show that on average 4.4% of the board directors has developed IT competence in a senior executive function, with the median being equal to zero. This suggests important variation in the source of director's IT knowledge.

Comparable to other governance studies, board independence is on average 71.1%, and the average logarithm of board size is 2.650, which equals on average nine directors (Van Peteghem et al., 2018). The descriptive statistics of the other control variables are in line with prior research (e.g. Cheng, 2008; Van Peteghem et al., 2018).

An untabulated correlation matrix shows that no excessive correlations exist. Most correlations are smaller than 0.2, with some exceptions of which the highest equals 0.57 – being the correlation between board size and firm size. An analysis of the variance inflation factors shows that the highest VIF equals 2.15. Multicollinearity is hence not considered to be a problem.

Table 2. Descriptive Statistoics						
	N	**Mean**	**Q1**	**Median**	**Q3**	**Std. Dev.**
ROA	32,942	0.042	0.022	0.072	0.121	0.173
RET	32,310	0.137	-0.202	0.046	0.313	0.624
OPEX	32,594	87.059	22.053	54.209	116.488	103.111
ITCOMP	32,942	0.230	0	0.125	0.286	0.298
EXECITCOMP	32,942	0.044	0	0	0	0.097
LNBSIZE	32,942	2.650	2.197	2.639	3.045	0.574
BINDEP	32,942	0.711	0.588	0.714	0.857	0.153
LNMEANAGE	32,942	4.093	4.046	4.096	4.145	0.078
LNTA	32,942	6.634	5.211	6.674	8.081	2.066
LNMARKETCAP	32,310	6.655	5.220	6.722	8.100	2.103
LEVERAGE	32,942	0.184	0.002	0.147	0.290	0.192
INTANTA	32,942	0.180	0.015	0.112	0.289	0.194
RDADV	32,942	0.173	0	0.016	0.082	0.759
MTB	32,942	2.859	1.286	2.073	3.493	4.325
LOSS	32,942	0.272	0	0	1	0.445
ALTMANZ	32,942	3.889	1.696	3.190	5.274	5.692
SALESGROWTH	32,942	0.266	-0.035	0.132	0.359	0.692
STDOCF5Y	32,942	0.074	0.026	0.047	0.083	0.095
STDRET5Y	32,310	0.699	0.260	0.405	0.670	1.074

Accounting-based Firm Performance (ROA)

Results from the estimation of the accounting-based firm performance model are shown in Table 3. Our dependent variable is the firm's return on assets (ROA). Model (1) shows that board IT competence is positively associated with the firm's return on assets (ITCOMP, coef. = .034; p = .002). This finding suggests that board IT competence can improve board oversight of IT assets, which can then enhance a firm's return on assets. The same pattern exists for IT competence developed in executive positions. Specifically, Model (2) shows that EXECITCOMP is positively associated with firm ROA (EXECITCOMP, coef. = .041; p = .066). The coefficient of 0.041 is larger than the coefficient of 0.034 in Model (1), which could suggest that IT competence is most valuable when developed in executive positions (Lim, Stratopoulos, et al., 2013b). However, its significance also is weaker and it is not significantly different from the coefficient of *ITCOMP*, warranting a cautious interpretation of this finding. In terms of economic significance, a one standard deviation increase in ITCOMP increases ROA by 1%. Jointly considered, our findings suggest that board IT competence positively affects firm performance, corroborating our hypothesis.

Table 3. Regression Analysis (*ROA*)					
	Coef.	**T-Stat.**		**Coef.**	**T-Stat.**
ITCOMP	0.034	3.10***			
EXECITCOMP				0.041	1.88*
Control variables	Included			Included	
Year Fixed Effects	Included			Included	
Firm Fixed Effects	Included			Included	
N	32,856			32,856	
Adjusted R^2	0.774			0.774	
P-Value Model	<.0001			<0.001	

Turning to the control variables, the results show that larger, financially stable firms with bright growth prospects are on average better performing (LNTA, p < .001; MTB, p < .089; ALTMANZ, p < .001).

Conversely, risky firms with larger boards and worse prior performance are associated with a lower ROA (LNBSIZE, p < .001; RDADV, p < .001; LOSS, p < .001; STDOCF5Y, p = .078). Larger boards may fall prone to communication costs, negatively affecting the board's advisory and monitoring role (Coles et al., 2008). The signs and significance levels are in line with prior research.

Market-based Firm Performance (RET)

The results from estimating the market-based performance model are contained in Table 4. We examine the association between board IT competence and stock returns (RET). Results in Model (1) shows that board IT competence is positively associated with the firm's stock returns, indicating higher market-based performance following increased board IT competence (ITCOMP, coef. = .112; p = .038). Moving to the proportion of the board having developed IT competence in executive positions, Model (2) shows that EXECITCOMP is positively associated with stock returns (EXECITCOMP, coef. = .189; p = .041). The coefficient of 0.189 is substantially larger than the coefficient of 0.112 in Model (1), suggesting that IT competence has the strongest effects when developed in executive positions (Lim, Stratopoulos, et al., 2013b). The difference between both coefficients is insignificant, which means that on average, we need to be cautious in our interpretation. However, both models clearly show the significant association between board IT competence and stock returns. In terms of economic significance, a one standard deviation increase in ITCOMP increases RET by 3.2%.

Turning to the control variables, the results show that – similar to the ROA model – larger boards are associated with lower stock returns, suggesting the existence of increased coordination and communication costs as boards increase in size (LNBSIZE, p < .001; Coles et al. 2008). Older directors are more likely to have developed their core competence prior to the emergence of information technologies, and are less able to adapt to new technology following changed cognitive demands (Czaja & Lee, 2007). Of the financial control variables, we find larger, stable, leveraged firms with better growth prospects and weaker prior performance to be associated with higher returns (LNMARKETCAP, p < .001; LEVERAGE, p < .030; MTB, p < .001; LOSS, p < .001; ALTMANZ, p < .001). The standard deviation of stock returns over the past five years is positively associated (STDRET5Y, p < .001). Conversely, R&D intense firms with a high proportion of intangibles and strong prior sales growth are associated with weaker stock returns (INTANTA, p < .001; RDADV, p < .001; SALESGROWTH, p < .001). These findings are generally in line with prior research.

Table 4. Regression Analysis (*RET*)

	Coef.	**T-Stat.**		**Coef.**	**T-Stat.**
ITCOMP	0.112	2.08**			
EXECITCOMP				0.189	2.04**
Control variables	Included			Included	
Year Fixed Effects	Included			Included	
Firm Fixed Effects	Included			Included	
N	32,225			32,225	
Adjusted-R^2	0.213			0.213	
P-Value Model	<.0001			<0.001	

Operational Efficiency (OPEX)

The results from estimating operating expenditures model are contained in Table 5. We examine the association between board IT competence and operating expenditures per employee (OPEX), hypothesizing that IT competent boards can more successfully deploy IT resources, enhancing the efficiency of operational and supply chain processes (Banker et al., 2006; Ilbebrand et al., 2010; Mithas et al., 2012). Results in Model (1) show that board IT competence is negative associated with the firm's operating expenditures, indicating the increased efficiency attained by IT competent boards (ITCOMP, coef. = -14.815; p = .017). A similar effect exists in Model (2), where we use a more specific definition of board IT competence to isolate IT competence developed in executive positions. Specifically, we find a statistically significant association between EXECITCOMP and operating expenditures per employee, which is larger in magnitude compared

to Model (1) (EXECITCOMP, coef. = -24.025; p = .026). Again, this association is not significantly different. In terms of economic significance, a one standard deviation increase in ITCOMP decreases OPEX by 4.5. Jointly considered, the results show that board IT competence enhances operational efficiency.

Table 5. Regression Analysis (*OPEX*)					
	Coef.	**T-Stat.**		**Coef.**	**T-Stat.**
ITCOMP	-14.815	-2.40**			
EXECITCOMP				-24.025	-1.99**
Control variables	Included			Included	
Year Fixed Effects	Included			Included	
Firm Fixed Effects	Included			Included	
N	32,510			32,510	
Adjusted-R^2	0.811			0.811	
P-Value Model	<.0001			<0.001	

Moving to the control variables, results show that board independence helps improve organization efficiency. The sign matches findings of prior research emphasizing independence as a necessary condition for strong board monitoring (Nguyen & Nielsen, 2010). We further find larger firms with weaker operational performance to be associated with higher operating expenses (LNTA, p < .016; LOSS, p < .067). Financially stable firms with a higher proportion of intangible assets and R&D and advertising expenses are associated with lower operational expenses (INTANTA, p < .037; RDADV, p < .001; ALTMANZ, p < .001).

Additional Analyses

Standard Deviation of Performance

Besides examining the direct effects of corporate governance on performance, a related stream of literature has explored the impact of the board of directors on the variability of performance. Volatile performance may come at a cost to shareholders and debtholders, who generally prefer stable cash flows or dividends. A higher volatility may then come as a significant cost to these stakeholders. A study by Cheng (2008) examines the impact of board size on firm performance variability, and shows that larger boards make less extreme decisions and are better able to monitor management, which lead to a lower variability of corporate performance. Building upon the same reasoning, we expect that IT competence enhances the monitoring and advisory role of the board, improving decision-making quality, thereby reducing the likelihood of extreme decisions and the corresponding performance volatility.

We follow the methodology of Cheng (2008) and calculate standard deviation of our performance measures at the firm level across our sample period. Next, we average all independent variables per firm. By doing so, we are left with a single observation per firm. We then run a regression tying the within-firm, over-time variability or corporate performance to the mean values of the underlying characteristics of these firms. Phrased differently, we tie a firm's performance volatility to the average board IT competence throughout our sample period. Results are shown in Table 6 and show that IT competent boards are associated with a significantly lower volatility in ROA, RET, and OPEX. Tied to our main analyses, the results suggest that board IT competence may not only increase firm performance, but may also do so in a sustainable way, as is evident from the reduced variation hereof. Firm performance is not only higher, but also more stable, bolstering our claims on the potential added value of board IT competence.

Endogeneity

A common problem in governance research is the endogeneity between governance structures and various firm outcome variables. When governance characteristics are not randomly distributed among firms, and their occurrence is indirectly related to firm performance, than any causal inferences are biased (e.g. Bhagat & Bolton, 2008; Coles et al., 2008). A potentially endogenous relationship between board IT competence and firm performance may exist, as better-performing firms may be able to attract better quality directors,

which could have superior competences. We address this concerns via a two-stage least square estimation, entropy balancing, and using two-year lagged values of our test variables.

Table 6. Standard Deviation of Performance									
		STDROA			***STDRET***			***STDOPEX***	
		Coef.	**T-Stat.**		**Coef.**	**T-Stat.**		**Coef.**	**T-Stat.**
ITCOMP		-0.027	-1.84*		-0.296	-2.68***		-17.428	-2.96***
CONTROL VARIABLES		YES			YES			YES	
N		3,269			3,269			3,242	
Adjusted R²		0.593			0.869			0.216	
		STDROA			***STDRET***			***STDOPEX***	
		Coef.	**T-Stat.**		**Coef.**	**T-Stat.**		**Coef.**	**T-Stat.**
EXECITCOMP		-0.085	-1.85*		-1.184	-3.18***		-40.245	-2.11**
CONTROL VARIABLES		YES			YES			YES	
N		3,269			3,269			3,242	
Adjusted R²		0.593			0.869			0.215	

In a first set of endogeneity checks, we rerun our main analyses using fixed effects two-stage least squares regressions. In a first step, we regress our endogenous variable, being our measures of IT competence, on a set of instruments, control variables and firm and year fixed effects. The instruments should be correlated with IT competence (instrument relevance), while being uncorrelated with board performance (instrument validity). In line with prior governance research, we choose as instrument the average of our endogenous variable within the same two-digit SIC industry in the same year (Faleye 2015; Van Peteghem et al. 2017). Our reasoning is the following. Prior research has established isomorphism in organizational structures, which has also been shown to hold for governance structures as well (Certo 2003). Phrased differently, board composition mimics that of its peers in order to increase organizational legitimacy. Prior research has indeed shown industry practices to be a significant determinant of board structure, either in terms of director age, independence or board size. Hence, board structure is likely associated with governance practices of industry peers, but the latter are unlikely to directly affect firm performance. We consequently posit average IT competence in the industry to be a valid instrument for board IT competence. We test the relevance of this instrument using the Stock and Yogo (2005) test as well as the Kleibergen-Paap-LM statistic, both of which confirm a strong association between our instruments and the endogenous variables. Moreover, untabulated analyses show that the endogenous variables strongly load on the instrument in the first stage regression. Jointly considered, we expect our instruments to satisfy the validity and relevance criteria. Results of the two stage least squares analyses are contained in Panel A of Table 7, and document comparable effects to our main analyses for all models. We further replicate the additional analyses examining the standard deviation of performance using industry averages of the test variables as instruments, and find similar results. In aggregate, the results of the two-stage least squares estimation support our main analyses.

In a second set of endogeneity checks, we employ an entropy balanced sample. If the choice of having IT competent directors is non-randomly distributed across observations, our inferences are biased. However, by reweighting observations in such a way that any systematic differences in the underlying characteristics are removed, we can filter away any bias originating in these observable characteristics (Hainmueller and Xu 2013). Applied to our setting, entropy balancing reweights observations in our dataset, so that no systematic differences exist between observations with IT competent directors on the board, and observations without board IT competence. The advantage of entropy balancing compared to a propensity score matching approach is that there is no loss of observations or low balance levels, and that a potential increase in bias regarding the treatment effect is avoided. It reduces endogeneity concerns by assuming that

adjusting the observed firm characteristics will lead to adjusted unobserved variables (Hainmuller and Xu 2013).

Table 7. Two Stage Least Squares and Entropy Balancing								
Panel A: Two Stage Least Squares								
	ROA		***RET***		***OPEX***			
	Coef.	**Z-Stat.**	**Coef.**	**Z-Stat.**	**Coef.**	**Z-Stat.**		
ITCOMP	0.291	3.04***	1.323	2.76***	-112.013	-2.18**		
N	32,856		32,225		32,510			
Centered R²	0.246		0.214		0.039			
EXECITCOMP	0.555	3.96***	2.714	3.96***	-141.127	-1.82*		
N	32,856		32,225		32,510			
Centered R²	0.239		0.208		0.051			
	STDROA		***STDRET***		***STDOPEX***			
	Coef.	**Z-Stat.**	**Coef.**	**Z-Stat.**	**Coef.**	**Z-Stat.**		
ITCOMP	-0.078	-2.94***	-0.279	-1.47	-62.996	-6.14***		
N	3,269		3,269		3,242			
Centered R²	0.593		0.870		0.204			
EXECITCOMP	-0.290	-2.67**	-1.332	-1.67*	-225.529	-5.42***		
N	3,269		3,269		3,242			
Centered R²	0.592		0.870		0.196			
Panel B: Entropy Balancing of IT Competent and Non-IT Competent firms								
	ROA		***RET***		***OPEX***			
	Coef.	**T-Stat.**	**Coef.**	**T-Stat.**	**Coef.**	**T-Stat.**		
ITCOMP	0.040	3.41***	0.131	2.25**	-14.981	-2.17**		
N	32,856		32,225		32,510			
Adjusted R²	0.784		0.220		0.809			
EXECITCOMP	0.060	2.30**	0.081	0.82	-28.076	-2.33**		
N	32,856		32,225		32,510			
Adjusted R²	0.794		0.223		0.814			
	STDROA		***STDRET***		***STDOPEX***			
	Coef.	**T-Stat.**	**Coef.**	**T-Stat.**	**Coef.**	**T-Stat.**		
ITCOMP	-0.053	-2.49**	-0.030	-0.17	-23.796	-2.96***		
N	3,269		3,269		3,242			
Adjusted R²	0.618		0.812		0.277			
EXECITCOMP	-0.085	-1.78*	-1.075	-3.49***	-22.600	-1.16		
N	3,269		3,269		3,242			
Adjusted R²	0.624		0.910		0.193			
Panel C: Two-Year Lagged Values of Test Variables								
	ROA		***RET***		***OPEX***			
	Coef.	**T-Stat.**	**Coef.**	**T-Stat.**	**Coef.**	**T-Stat.**		
ITCOMP	0.026	2.41**	0.116	2.12**	-14.120	-2.09**		
N	30,029		29,550		29,749			
Adjusted R²	0.802		0.227		0.821			
EXECITCOMP	0.018	0.79	0.173	1.57	-30.072	-2.26**		
N	30,029		29,550		29,749			
Adjusted R²	0.780		0.227		0.821			

Results of the matching procedure are shown in Panel B of Table 7. Whereas large differences existed pre-matching, an untabulated comparison shows that the reweighted sample no longer shows any significant differences in the underlying characteristics between the treatment and non-treatment observations. Subsequent fixed effect regressions yield similar results to our main models, both regarding the effects of IT competence on performance as well as regarding its impact on the variability of performance.

In a third set of additional analyses, we aim to further alleviate concerns regarding reverse causality, and assess the stability of our results to using lagged values of our test variables (Mithas et al., 2012). We re-estimate our main regressions using two year lagged values of board IT competence. Results are shown in Panel C and are in line with our main findings. Jointly considered with Panels A and B, these results strengthen our main inferences documenting an important impact of board IT competence on firm performance. Results are similar when using one-year lagged values.

Summary, Contribution and Limitations

This study aims to better understand the role of the board of directors in improving board level IT governance, and its subsequent impact on firm performance. We theorize a new construct "IT Competence" and show that it is systematically related to firm performance. Our finding show a clear association between board IT competence on firm performance. Specifically, we find that both accounting and market-based performance are positively associated with board IT competence, and further show a negative association between operating expenses and IT competence. Initial evidence exists that these effects could be stronger when the IT experience is matched with management experience in a CEO, CIO or CTO function in the IT sector. In additional analyses, we further show that higher levels of board IT competence not only improves firm performance, but also decreases the variability of performance. Jointly considered, our analyses show the potential added value of IT competent boards in enhancing firm performance. This conclusion is robust to different designs taking into account the potentially endogenous relationship between corporate governance and firm outcomes, though we caution further researchers that more evidence is necessary.

Our study offers several contributions to the information systems literature. First, our study contributes to the existing body of IT governance and information systems leadership literature by examining the role of board level IT governance. Although prior information systems literature has extensively investigated the role and impact of senior executives on firm performance, our understanding about the role of board members remain limited. To this end, we theorize the construct of board IT competence using agency theory, resources dependence theory, and strategic choice theory. Second, we provide a novel approach to construct a measure of board IT competence. Specifically, we measure IT competence at two levels: board IT competence and executive IT competence. Board IT competence captures prior executive and board experience in IT sector. Executive IT competence is more fine-grained, and observes the prior experience of the board members in the capacity of CEO, CIO, or CTO in the IT sector. Both measures provide a robust operationalization of IT competence. Third, whereas prior information systems leadership research advocates the role of the CIO at the board level, we provide empirical evidence that the board of directors can play a key role in translating IT resources into firm performance.

From a practical implication aspect, the study offers several recommendations to the board of directors in the advent of emerging technology challenges. Many firms struggle to identify the right sources in developing IT competence at the board level. To address this, firms can benefit from appointing IT competent board members. Particularly, a board composition that promotes the representation of directors with relevant IT competencies can offer valuable insights to mobilize and reconfigure IT asset to develop IT capability.

We recognize that our study has some limitations. First and foremost, we are quantifying board IT competence on the basis of the prior employment history of the firm's directors. Given the data limitations, our measure is not able to take director education into account, which could be relevant as it provides the director with an IT mindset and background. However, directors with a passion for IT will likely at some point have taken on an appointment in an IT firm, either in an executive function or on the board. Hence, we do not expect this shortcoming to instigate a large bias in our measure. Second, we do not take into account board leadership. However, the chair of the board is the main liaison between management and independent directors, and a key player in modern corporate governance. Higher levels of board IT competence may then be less necessary when the chair possesses a high level of IT competence himself.

Third, we disregard contextual variables that could affect the impact of board IT competence on firm performance, such as e.g. competition, innovation, or environmental uncertainty . For example, it might be valuable to investigate how board IT competence contributes to strategic posture of the firm. Finally, future research should examine the underlying mechanisms (e.g., how board IT competence shapes levels of IT investments of firms, returns on IT investments, and firm risk) for stronger causal inference, and the moderating influence of other factors to illuminate the boundary conditions of theorizing articulated in this paper (e.g., Kim et al. 2017; Mithas et al. 2012; Mithas et al. 2013). We leave the pursuit of these research questions to further research.

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